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THE CULTURE OF FLUE-CURED TOBACCO.

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INTRODUCTION.

In its origin the flue-cured type of tobacco is associated closely with the old Virginia dark type and is really an offshoot from the latter, dependent primarily upon soil modification. Later the type was further modified and differentiated by cultural adaptations prompted by trade preferences. As the cultivation of tobacco in Virginia was pushed back to the lighter sandy lands of what is now the southern tier of counties of that State and the adjoining counties of North Carolina, the character of the tobacco produced was naturally somewhat changed. It was milder and generally lighter in color and became popular for home consumption, particularly as a chewing tobacco. It was preferred also by a certain class of the export trade, particularly in France, where the milder, lighter tobaccos were more popular. The dark Virginia tobacco was cured by means of open fires and smoke, which gave it a smoky, creosotic odor and flavor. This smoky flavor was objectionable to the trade desiring the milder tobacco, and the use of open fires in curing was limited as much as possible, and much of the product was merely air cured, fires being used only when necessary to protect it from damage in damp, muggy weather. Charcoal was often substituted for wood in order to keep down the odor of smoke. The use of charcoal grew to be the regular practice until, in turn, it was superseded by the use of flues, which came into use soon after the close of the Civil War. At first these flues were constructed of rock, but later they were made of sheet iron, as is the almost universal practice to-day. The use of flues still further did away with any tendency to smokiness and gave more uniformly satisfactory results in obtaining lighter and more uniform colors, as well as greater convenience in tending the fires.

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Up to a time just before the Civil War, however, the production of this yellow type of tobacco was confined principally to Caswell County, N. C., and Pittsylvania County, Va. The real development in the flue-cured type did not take place until during the decades immediately succeeding that in which the Civil War occurred, and on its present basis, therefore, it is essentially a modern type.

A number of important and clearly defined factors are easily discernible as stimulating and promoting this development. From the standpoint of consumption, the demand was rapidly expanded by the growing popularity of pipe smoking in this country, for which this flue-cured type, in the form of granulated smoking tobacco, proved to be highly satisfactory, and also to the introduction and rapid expansion in use of machine-made cigarettes. The greatly enhanced demand for tobacco of this type also extended to foreign countries, especially to Great Britain and certain of the British possessions. Supplementary to this great expansion in demand, resulting in good prices for the raw leaf, production was also markedly stimulated during this same period by the introduction of commercial fertilizers, upon which the profitable production of flue-cured tobacco now so largely depends. By the middle eighties, therefore, the producing area and use of flue-cured tobacco had greatly enlarged and covered, as a crop of dominant importance, some 20 counties in the northern part of central and western North Carolina and in south central Virginia, thus embracing the Old Belt section about as it is known to-day. Prior to about 1890 little tobacco was grown east of Warren, Franklin, and Wake Counties, N. C. During the nineties the demand for flue-cured tobacco, especially of the brighter types, continued to expand, and in this same period the price of cotton was very low. This combination of circumstances resulted in a widely extended movement on the part of the farmers of eastern North Carolina and South Carolina to try tobacco growing where formerly attention had been given almost exclusively to cotton. So rapidly was the acreage expanded throughout this cotton-growing Coastal Plain section of eastern North Carolina and South Carolina, now known as the New Belt, that in 1903 this new section actually produced more tobacco than was grown in the Old Belt section. Because of this large production in the New Belt, the total crop of flue-cured tobacco of that year for both the New Belt and the Old Belt amounted to upward of 250,000,000 pounds, the largest crop produced up to the present time. This great crop year ushered in a period of lower prices, and production dropped off markedly in succeeding years, particularly in the New Belt, where attention was again turned to cotton, for which prices for several years were comparatively good. In 1911 and 1912 the flue-cured tobacco crop was considerably curtailed because of very

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unfavorable weather conditions, and prices for the brighter types of leaf again became very high, foreshadowing a greatly increased interest and expansion of acreage, more especially in the New Belt section, where the acreage and production fluctuate much more widely than in the Old Belt because of the opportunity for shifting between cotton and tobacco as conditions seem to warrant.

At the present time, the normal annual production of flue-cured tobacco on a farm-weight basis is estimated to be about 215,000,000 pounds. Of this total about 120,000,000 pounds is produced in the Old Belt section and 95,000,000 pounds in the New Belt.[1] The average annual production of tobacco in the United States is now close to 1,000,000,000 pounds, of which the flue-cured type is approximately one-fifth. White Burley is the only other type that has had such a rapid expansion in production and popularity in so limited a period of years. As in the case of Burley, the rapid development of flue-cured tobacco is undoubtedly founded largely on its adaptability for meeting the popular demand for light, mild tobacco in the different forms in which it is consumed.

All things considered, this flue-cured type of tobacco is unsurpassed in universal popularity and general adaptability to a variety of uses, including granulated and cut smoking tobacco, both paper and all-tobacco cigarettes, and plug filler and wrapper; in fact, it is adapted to all the regular forms in which tobacco is used except standard cigars and snuff. In color and general appearance it is very attractive, while its low nicotine content, mildness, aromatic sweetness, fragrance, and good keeping qualities render it very satisfying to the user.[2]

It may also be noted that this type is the only one that has had any decided tendency to expand our exports in recent years. Of the total quantity of flue-cured tobacco produced, about 40 per cent, or around 90,000,000 pounds, is exported, and the remainder is used in domestic consumption.

SOILS OF THE FLUE-CURED DISTRICT.

Speaking broadly, the current trade differentiations of the flue-cured producing area into the Old Belt and the New Belt sections indicate also a fairly well-defined modification in the character of the tobacco produced in these two sections. The best tobacco soils of both the Old Belt and the New Belt are all light and sandy, but those of the New Belt, in the Coastal Plain, are lighter and more sandy as a class than are those of the Old Belt in the Piedmont section, and these soils, and especially the subsoils, become progressively

[1] For additional information concerning the general features of the flue-cured type, including a list of the counties producing flue-cured tobacco, with the estimated average quantity of tobacco produced in each, see Bulletin 244, Bureau of Plant Industry, U. S. Department of Agriculture.

[2] U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 244, p. 70, 1912.

more clayey as one progresses westward toward the mountains. The lighter Coastal Plain soils characteristically produce a brighter and paler type of leaf than the Old Belt soils, but with less body and richness. In the western part of the Old Belt, particularly from about Rockingham County, N. C., and Henry County, Va., the rich waxy filler types predominate, while the colors run in much larger proportion to mahogany or red. Soil adaptation is a very important factor in the production of a satisfactory quality of flue-cured tobacco. It is an influence of fundamental importance in determining the color of the leaf produced, as well as such other points of quality as fineness, richness, and body. In general, the soils adapted to the production of flue-cured tobacco may be described as light and sandy to a depth of 6 to 10 inches, underlain with a sandy-clay subsoil of a yellowish orange color.

The whiter soils produce the brightest tobacco, unless offset by some other factor. The clay of the subsoil is an important factor in giving the leaf richness and body, and it is also an aid in retaining fertility. In the Coastal Plain section some of the soils are such loose, deep sands as to constitute an extreme of the bright-tobacco type. Such soils will naturally produce a very bright tobacco, but the leaf is likely to be lacking in body and richness, and the soil itself is at a disadvantage in retaining fertility and is not likely to withstand wet weather well. On the other hand, the soils of the Old Belt section, more especially in the western part, frequently represent the other extreme of being too clayey and too red to produce anything more than a dark tobacco, although, generally, the leaf will be rich and waxy. Between these soil extremes of the New Belt Coastal Plain section, some of them tending to be too extremely sandy and open, and the clayey soils of the western part of the Old Belt section, there is to be found almost every conceivable variation in shade, depth, and mechanical structure.

From a chemical standpoint, bright-tobacco soils are rather weak, as is to be expected from their high content of sand or silica, but most of them are very responsive to artificial enrichment by means of fertilizers, manure, and soil-improving crops. The relatively light soils which predominate in the New Belt section naturally are less well supplied with mineral plant food materials, particularly potash, than are the stronger soils of the Piedmont section. However, a soil possessing ideal mechanical and chemical qualifications may be entirely unsuited to tobacco unless it has good natural drainage, as it is ruinous to a tobacco plant to stand for any length of time in a water-logged soil.

In the earlier days of tobacco culture, before commercial fertilizers came into general use, it was the almost universal custom to plant tobacco on " fresh," or recently cleared, land. On such land

there is an accumulation of readily available plant food; the tobacco grows quickly, matures and ripens early, and cures well. In the Old Belt, therefore, where much of the soil tends to be too strong and clayey, a given soil, perhaps, will produce a crop of good color and quality when it is "fresh," but will not do so after it has been under cultivation for a number of years. But in the case of the light soils in the Coastal Plain section, those which have been longer under cultivation are preferable because the "fresh" land will make the leaves too thin and lifeless and the bottom leaves will begin to waste away prematurely.

CROP ROTATION SYSTEMS.

Aside from the natural character of the soil itself, there is no more important matter for the tobacco grower to consider than the management of his fields, so that in regular order they will be in the best shape for tobacco at the proper time. Indeed, the character of the tobacco produced will depend quite as much on how the fields have been handled in rotation between the successive tobacco crops as upon the fertilizer used or the cultivation given directly to the tobacco crop itself.

IMPORTANCE OF HUMUS IN THE SOIL.

Tobacco land should be so handled as to be kept in good life. A liberal supply of vegetable matter in an advanced stage of decay is highly desirable, but it should be of a kind not excessively rich in ammonia. For this reason the clovers, cowpeas, and other legumes, except in a limited way, generally can not be used with satisfaction preceding tobacco unless removed some two or three years from the tobacco, and on the stronger lands of the Old Belt section it would probably be best in most cases to omit them from the rotation altogether. Large quantities of slow-acting organic ammoniates tend decidedly against fineness, sweetness, and color.

It is well known that the organic matter of freshly cleared or broom-straw fields is of a kind well suited to tobacco. It consists principally of dead leaves, twigs, roots, pine tags, or broom straw and roots. Such vegetable matter, while poor in ammonia, by its ample volume makes the soil very mellow and friable and of good water-holding capacity. The weed growth that comes in spontaneously on the so-called rested fields is also generally of a kind suited to turn under as a source of vegetable matter for tobacco soils.

Supplying the necessary humus in this way perhaps may be considered satisfactory from the standpoint of the tobacco itself. In several other respects, however, it is very unsatisfactory. The rested field system of farming, if it may be called a system, means that a

part of the farm is at all times out of commission and not producing any profitable crop. It also means that many undesirable weeds and bushes are given every opportunity to reseed or reestablish themselves, and it gives the country the general aspect of being roughly and poorly farmed. As such it represents an antiquated, crude, and unsatisfactory type of farming from which we are now trying hard to get away.

In the New Belt section the growing of tobacco on freshly cleared land is unsatisfactory for the reason already mentioned, while in the Old Belt the proportion of the tobacco crop grown on fresh land is already small, and it is evident that it must in the future constitute a smaller and smaller proportion of the area planted to tobacco. On old land there is no more important problem in the production of fine, bright tobacco than how best to maintain in the soil a sufficient supply of the right kind of decaying vegetable matter, upon which its life and mellowness so largely depend.

Among the more satisfactory sources of vegetable matter for tobacco soils of the flue-cured district we may note the rye (or other small grain) fallow and the herd's-grass sod. Rye is in every respect satisfactory from the standpoint of its effect on the quality of the tobacco. It is thought well of by tobacco growers generally throughout the entire flue-cured district, but it is open to one very serious objection for general use as a crop to immediately precede tobacco. Its use necessitates the spring plowing of the land at a time when the teams are always rushed, and very frequently the land will be either too wet or too dry, or some other cause will too often prevent the proper fitting of the land early enough, or well enough, for the best results. When rye is used and turned under entire, it should not be allowed to get too tall and hard. It is best to turn it down when it is about knee high, and before being turned under it should be thoroughly cut into the soil by going over the field two or three times with the disk harrow, lapping halfway each time so as not to throw the field into ridges. The thicker and ranker the growth of rye, the more imperative it is that a thorough job be done with the disk before the land is plowed. If the rye is cut and removed from the field, the stubble should likewise generally be thoroughly cut to pieces with the disk before plowing the land.

GRASS IN THE TOBACCO ROTATION.

All things considered, there is probably no better humus crop for the tobacco rotation than herd's-grass or redtop, at least on practically all the tobacco soils of the Old Belt section and the stiffer soils in the New Belt. Aside from its value as a humus-yielding, soil-improving crop, suited to the tobacco rotation, redtop is a very valuable hay grass. It is suited to southern conditions and will give

a good yield of splendid hay, which may be utilized as a secondary source of money income on the tobacco farm, either through direct sale or indirectly through live-stock products.

For the best results with herd's-grass, the seed should be sowed from the middle to the last of August in the Old Belt and not later than September 20 in the New Belt Coastal Plain section. The preparation of the seed bed is a matter of prime importance in securing a good stand of grass. This is best accomplished without the turning plow, unless it be used some weeks or months before the grass is to be seeded. Instead, the field should be gone over with the disk harrow in July or August, followed by the smoothing or drag harrow just before sowing the seed. What is needed is a fine but shallow seed bed (preferably not more than 1 or 2 inches deep) with a firm under soil, and this condition can best be secured if the turning plow is not used. The place of the grass in the rotation, particularly in the Old Belt section, generally will be after wheat or oats, one of which has, in turn, probably succeeded the tobacco; that is, the grass will be seeded on wheat or oat stubble after the soil has been fitted during July and August, as mentioned. The disk should be started at the first opportunity after the grain is removed, so as to prevent the weeds from getting so large as to interfere with a satisfactory and economical fitting with the disk harrow.

Before seeding the grass, from 400 to 800 pounds of 3–8–3 fertilizer[1] or its equivalent should be broadcasted per acre. On the stiffer soils, if already in a fairly good state of fertility, the smaller quantity might suffice, but on the sandier soils, especially if run down in fertility, the larger quantity would be likely to give more satisfactory results. To insure an even stand of grass, the field should be gone over both ways in sowing, using a total of about 15 pounds of seed to the acre. After seeding, the field should be again gone over with the smoothing harrow, to lightly cover the seed, and then thoroughly rolled. Early in the spring, when the young grass begins to start, top-dress the field with about 200 pounds of nitrate of soda per acre, distributed in two applications about two weeks apart. The nitrate is best applied just before or during a rain, so that it will be dissolved, soak into the ground, and begin to feed the grass at once without any danger of injury by burning. After the lumps are crushed, the nitrate can be easily distributed directly by hand without increasing the bulk by mixing with sand or other filler. When making the second application of the nitrate, special attention should be given to any spots which, from the appearance of the grass, seem to have been missed in going over the field the first time. From this procedure a valuable hay crop of 1½ to 2 tons or more

[1] The formula "3–8–3" refers to the percentage of ammonia, phosphoric acid, and potash, respectively.

per acre should result. Figure 1 shows the effect of nitrate of soda on grass grown in a tobacco rotation. The grass generally should be allowed to stand two years, when the sod may be turned down in the fall or winter in preparation for tobacco the next year. This fall plowing is a very important point, especially in the Old Belt, as it practically assures that the soil will be well fitted and early enough fitted to give the tobacco the best chance to do well.

OTHER CROPS OF THE ROTATION.

It is impracticable to attempt to lay out any definite rotation plan adapted to the needs of all tobacco farms. For the Old Belt section, however, where there is less diversity in so-called money crops, a rotation in which tobacco is followed directly by oats or wheat and

FIG. 1.—A field of grass showing the effect of nitrate of soda. On the right the grass was hardly worth cutting, while on the left, where nitrate of soda was used, a yield of nearly 2 tons to the acre was obtained.

then by two years of grass, as suggested above, would undoubtedly be found practicable and suited to the majority of tobacco farms. A number of possible variations from this plan will quickly suggest themselves. For example, if this system of cropping, supplemented perhaps by liberal fertilizing or manuring, tends to make the soil too rich for the best results with tobacco, the difficulty could probably be overcome by introducing corn into the rotation directly on the grass sod in place of the tobacco. A good crop of corn should result, and it would do much in the way of reducing the surplus fertility, for corn is an exhaustive crop, particularly on light land. This would lengthen the rotation to five years and bring the tobacco directly after corn. There is one serious objection to this plan. Corn frequently harbors large numbers of wireworms, which might

make it difficult to get a stand of tobacco because of the attacks of the wireworms on the young plants as soon as they are set out. This difficulty in turn could be successfully overcome by following the corn with oats, making a six-year rotation, the field coming back to tobacco again in the seventh year. Another variation would be to follow the tobacco with corn and then with oats or wheat, to be followed in turn by the two years of grass, making a five-year rotation and putting the tobacco on the grass sod, as in the four-year rotation first mentioned.

In the New Belt there is a greater diversity of money crops. Cotton, peanuts, and sweet potatoes may be mentioned, and among these cotton would be the one most generally desired because of its ready market and wide adaptability throughout the New Belt section. Legumes are also much less objectionable on the light Coastal Plain soils, and in many instances a legume could be introduced into the rotation with benefit. In most cases cowpeas probably would be found most satisfactory for this purpose, or, on the stiffer soils where it will hold through the winter, crimson clover also might often be used to advantage. When used, these legumes should generally come in the rotation closely succeeding tobacco, so that any excess of ammonia which they might supply could be used up to some extent by the crops intervening before the field comes to tobacco again. On some of the very lightest unimproved soils, tobacco might give good results even if directly following a turned-under leguminous crop, such as cowpeas.

On the stiffer soils of the New Belt, the four-year rotation suggested for the Old Belt, namely, tobacco followed by winter oats and then two years in herd's-grass, would be practicable in some cases. If it is desired to put cotton in the rotation, satisfactory results should be obtained by seeding the field to cowpeas as soon as the oats are removed. The peas should be fertilized liberally with phosphoric acid and potash (say, 200 to 400 pounds of 16 per cent acid phosphate and 100 pounds of sulphate of potash), and the peas could either be mowed for hay or turned under, generally the latter when it is desired to improve the soil, as the condition of the field or the need for the hay makes most desirable. The cotton could follow the peas, after which the field could be planted in tobacco again, making a three-year rotation. If the pea vines were turned under, this system ought to keep the soil well supplied with vegetable matter, and good crops of both cotton and tobacco should result with the addition of but comparatively small amounts of nitrogen in the fertilizer. The oat crop should be top-dressed early in the spring with about 200 pounds of nitrate of soda per acre, in the manner recommended for grass.

Peanuts or sweet potatoes could be introduced into the rotation if desired, either in place of or succeeding the cotton. Peanuts are

a leguminous crop, but since both the vines and the roots are removed in harvesting (unless used for grazing hogs) they may be considered an exhaustive rather than an improving crop. Sweet potatoes, however, leave practically everything on the field except the potatoes themselves, which are principally starch, and this crop, therefore, tends to improve the soil. The vines decay very rapidly and their plant-food content, although rather small, soon becomes again available. Here again the rotations mentioned are to be considered only as suggestive, and any number of variations will readily suggest themselves to the thoughtful farmer; but the importance of maintaining a bountiful supply of vegetable matter of a kind not too rich in nitrogen at the time the field comes in tobacco should always be kept clearly in mind when planning the rotation.

FERTILIZERS FOR FLUE-CURED TOBACCO.

Bright-tobacco soils as a class are naturally rather infertile; but they are light and friable and of a character to respond readily to fertilizers, particularly in producing a crop of high money value like tobacco. Fertilizers increase the chances of profit from growing bright tobacco in two ways. They greatly increase the yield, sometimes by 100 per cent or more, and if properly balanced they generally improve the quality. Because of the natural deficiencies of bright-tobacco soils and because of the special adaptability of commercial fertilizers to bright tobacco there are no other types of tobacco produced in this country on which fertilizers are so freely used, except on some of the high-priced cigar-wrapper types in New England and Florida.

A so-called complete fertilizer—that is, one containing each of the three materials, ammonia (nitrogen), phosphoric acid, and potash—is generally needed, and the maximum yield can not be secured unless each is supplied in sufficient quantity. No general rule as to the proper proportion or balance between these materials can be given, and the farmer must exercise judgment in the matter. The best proportion for the three elements is likely to vary considerably on different fields, according to the soil and its state of improvement. As stated, each of these elements has its effect in limiting the yield; but, aside from this, there is, broadly speaking, a special effect on the quality of the leaf that may be attributed to each element. Too much ammonia, especially if unsupported by a sufficiency of the other fertilizing compounds, particularly phosphoric acid, will make the tobacco coarse, dark, and late in maturing, with a tendency to damage by "red fire" or dead spots here and there on the leaves. Without a sufficient supply of ammonia, however, the tobacco will be small, thin, and poor, although the color may be good.

Potash, like ammonia, improves the body of the leaf, and it has a decided value in tending to diminish or prevent "diseasing" or "specking." On the light, sandy soils of the New Belt section especially, potash should be applied much more liberally than is now the general custom.

Phosphoric acid may be considered the most generally needed plant-food material throughout the tobacco-growing region under consideration. It not only increases growth but hastens maturity, and also strongly tends to brighten the color because of its decided effect in ripening the leaf. By reason of this specific effect in thus improving the quality phosphoric acid should be used liberally in the tobacco fertilizer, particularly on the better improved soils, which, from an accumulation of nitrogenous materials, might tend to produce a dark, coarse leaf. On the other hand, some caution should be exercised not to use it excessively on unimproved very light soils. On such soils there is natural danger from premature ripening, or "firing," as it is usually called, and such tendency would be increased by an excessive application of phosphoric acid, though increasing the ammonia supplied in the fertilizer or otherwise would tend to overcome this difficulty with probable increased growth as well. This largely explains why the turning under of a leguminous crop immediately preceding tobacco on such unimproved very sandy soils may sometimes result in positive benefit.

Generally speaking, phosphates (except as just indicated) and potash may be used freely on flue-cured tobacco without injury to the quality, but it requires nice adjustment of the ammonia supply to give the best results. As stated, too little will make a "poor," thin tobacco of small growth, while too much will tend to make the tobacco dark, coarse, and rank smelling. Ammonia in the soil comes almost entirely from decaying vegetable matter or manure, and the quantity of ammonia to be used in the fertilizer will depend largely on how much may be expected from these sources in the soil. A crop of 1,000 pounds of tobacco to the acre, to produce the leaf, stalk, and roots, will need to assimilate about 75 pounds of ammonia (equivalent to approximately 62 pounds of nitrogen). On poorly improved sandy soils, generally producing around 600 pounds of tobacco to the acre under ordinary fertilization (say, 500 pounds of 3–8–3 fertilizer to the acre), the yield and quality generally could be improved greatly and the crop made more profitable by using an increased amount of ammonia in the fertilizer. On such a soil, out of the 75 pounds of ammonia necessary to produce a 1,000-pound crop it would not be unreasonable to supply in the fertilizer 40 or 50 pounds of this material (equivalent to 250 or 300 pounds of 16 per cent dried blood).

Both phosphoric acid and potash are generally needed on practically all the tobacco soils of the flue-cured district, although potash is perhaps of somewhat less importance on the stronger soils of the Old Belt section. Neither of these materials is likely to do harm, and any unused portion will not be lost by leaching (except possibly on some of the very deep loose sands of the Coastal Plain section) but will remain to benefit succeeding crops of the rotation. It would undoubtedly be wise, therefore, to use these materials somewhat more freely than has been customary. In the New Belt this recommendation would apply more particularly to potash, because the soils there are relatively more deficient in that constituent, while in the Old Belt, particularly on the more clayey soils, phosphates are more urgently needed, although a considerable increase in the potash used, particularly on the lighter soils, would also be desirable.

For general use it would seem reasonable to recommend as a base the use of from 400 to 600 pounds of 16 per cent acid phosphate per acre and in the Old Belt about 100 pounds of sulphate of potash (analyzing 48 to 50 per cent actual potash, K_2O) or for the lighter soils of the New Belt 150 to 200 pounds of the sulphate of potash per acre.

The amount of ammonia to be used with these quantities of phosphoric acid and potash, as indicated above, would depend largely on the condition of the particular field under consideration. In general, it may be stated that proportionately more ammonia can be used profitably on the light sandy soils of the New Belt than on the stronger Old Belt soils. Another factor of importance, particularly in the western part of the Old Belt section, is the time of harvesting and curing. If the crop ripens and is cured in warm weather, say, up to September 10, the tobacco will naturally tend to yellow well and cure bright, as compared with the same tobacco harvested and cured in the cool weather of late September and October. The normal period for curing tobacco in the New Belt is during July and early in August, which are hot-weather months, and this is a factor distinctly favorable to a good bright cure. Tobacco that ripens and cures during hot weather, particularly if the soil be rather dry, can satisfactorily utilize a larger amount of ammonia than when the harvest is in cool weather, and wet weather just before the tobacco is harvested is an additional adverse factor. Increasing the phosphoric acid, as noted above, will tend to brighten the leaf and thus overcome some of the harmful effects of too much ammonia.

In the Old Belt section under average conditions, particularly on the stronger type of soils of the western part, probably about 150 pounds of 16 per cent dried blood (or its equivalent in some other good ammoniate) would give approximately the right proportion of

ammonia for the minimum amounts of phosphoric acid and potash mentioned above. The formula would be as follows:

	Pounds.
Dried blood, analyzing 16 per cent ammonia	150
Acid phosphate, analyzing 16 per cent phosphoric acid	400
Sulphate of potash, analyzing 50 per cent potash (K_2O)	100
Total	650

Such a mixture, while weighing only 650 pounds for an acre of land, would, in the quantities of plant food carried, be approximately equivalent to an 800-pound application per acre of a fertilizer analyzing 3 per cent ammonia, 8 per cent phosphoric acid, and 6 per cent potash. If desired, cottonseed meal (analyzing 7½ per cent ammonia) might be substituted for the blood, using twice the number of pounds; or nitrate of soda (analyzing 18 to 19 per cent ammonia), at the rate of about two-thirds the number of pounds of blood, could be used. Generally speaking, however, cottonseed meal is somewhat less active than blood on the basis of equivalent quantities of ammonia, while there may be some question whether nitrate of soda does not affect unfavorably the quality of the leaf produced.

The cost of the 650 pounds of fertilizer shown in the formula will vary somewhat from year to year, but will generally be about $10. In certain cases, of course, as when the soil had been considerably improved by the use of manure or leguminous crops, even a smaller quantity of ammonia than here mentioned might give better results. In extreme cases, especially when color is an important factor, the ammonia might be omitted altogether. On the other hand, in the case of the lighter types of soil in the Old Belt, particularly in the eastern part of that section, where the lighter types of soil predominate, the proportion of ammonia in the fertilizer generally could be somewhat larger than that shown in the above formula. For these conditions 200 pounds of blood, or even more in some cases, might be a better balance and prove more profitable.

In the New Belt section, with the combination of still lighter and weaker soils and early harvesting in warmer weather, a materially richer fertilizer could undoubtedly be used to advantage in most cases, and for that section a mixture may be recommended for average conditions composed about as follows:

	Pounds.
Dried blood, analyzing 16 per cent ammonia	250
Acid phosphate, analyzing 16 per cent phosphoric acid	500
Sulphate of potash, analyzing 50 per cent potash (K_2O)	150
Total	900

This mixture of 900 pounds for an acre of land would be equivalent in plant-food value to a 1,000 pound per acre application of a

fertilizer analyzing 8 per cent of phosphoric acid, 4 per cent of ammonia, and 7½ per cent of potash. On the very lightest soils of the New Belt section, for reasons already mentioned, better results might be obtained by reducing the phosphoric acid, say, to 400 pounds, or by increasing the blood (ammonia) to 300 pounds or more, thus narrowing the ratio between the ammonia and phosphoric acid to 5 or 5½ to 8 instead of 4 to 8 as shown in the formula as given.

Fertilizers for tobacco are generally applied in the row, and when used in the ordinary quantities better immediate effects are no doubt realized. When considerable fertilizer is used in the row, however, even in the quantities mentioned above, it should be thoroughly incorporated with the soil by running a double-shovel plow with narrow teeth along the row before it is bedded. When large quantities of fertilizer are used, it might be best to apply at least half broadcast. In connection with the use of fertilizers, it is assumed that the humus supply has been given due consideration, thus insuring a good physical condition and moisture-holding capacity. A tight, drought-stricken, or badly drained soil can not be expected to become very productive just by increasing the supply of plant food in the form of commercial fertilizers.

In the above discussion no special mention has been made of the relative value of the different sources from which the plant-food materials may be derived, and this has purposely been omitted for the sake of brevity. It should be stated, however, that the materials mentioned may be regarded as standard, in the light of our present knowledge, and as good as anything now on the market.

As a source of potash, however, the sulphate should generally be given the preference in a tobacco fertilizer. The other materials most likely to be used as a substitute are muriate of potash and kainit. Both of these materials contain large quantities of chlorin, which has a tendency to make the tobacco burn poorly. Complaints have frequently been made as to the poor burning quality of flue-cured tobacco, particularly in respect to tobacco from the New Belt section, and it would be unwise to use anything in the fertilizer which would tend to strengthen the basis for this criticism.

BARN MANURE FOR FLUE-CURED TOBACCO.

While commercial fertilizers are and of necessity must remain the chief reliance of the tobacco grower, barn lot or stable manure is used to some extent on bright tobacco, although it has opponents as well as advocates of its suitability for this crop. In so far as its use may be considered objectionable, the objection has the same basis as that of other organic materials overrich in ammonia, namely, the tendency to make the tobacco coarser and darker. The lighter and poorer the land in respect to other ammoniates, the more likely is the

manure to be found desirable and advantageous. The way in which the manure is used is also an important factor in determining its effect on the quality of the crop. If well rotted and applied some months before the tobacco is planted, it can generally be used in moderate quantities with decided benefit, except, as already indicated, on lands already abnormally rich in ammonia. Where possible, it should be applied the fall before planting the tobacco, and certainly not later than the first of March. When used at the rate of 2 or 3 tons to the acre it can be applied in the row. When used in larger quantities (5 or 6 tons per acre is about as heavy as it is generally advisable to use manure for bright tobacco as a direct application), it should be broadcasted over the land and either harrowed or plowed in. Only fine, well-rotted manure should be used in the row, and it should be applied as much as two months before planting if possible. In using manure in this way the rows may be laid off in February or early in March and the manure put out and covered with the turning plow. Just before planting time these rows may be reopened with a single-shovel plow, the additional fertilizer applied, and the land rebedded in preparation for setting the tobacco.

Where tobacco succeeds herd's-grass in the rotation, an excellent method is to apply the manure to the grass during the winter before the last season the field is to stand in grass. This would greatly help the hay crop and give the manure time to become thoroughly decomposed and incorporated with the soil.

THE USE OF LIME ON FLUE-CURED TOBACCO SOILS.

Most flue-cured tobacco soils contain sufficient lime to fill direct plant-food requirements, but not enough generally to keep them from becoming rather acid. Their general crop-producing power through enhanced bacterial efficiency would usually be improved if they were occasionally limed. The grass especially would yield much better if lime were occasionally used. The direct effect of lime on the tobacco, however, may be somewhat injurious to the quality. By hastening the decay of the vegetable matter in the soil it increases the ammonia supply, and on soils already tending to be overrich the lime will tend still further to make the tobacco dark and coarse, the same as if an increased supply of ammonia were rendered available in any other way.

On some very poor soils, however, lime might result in both a larger yield and better quality because of the increased food supply rendered available.

It is somewhat a matter of controversy, also, whether lime does not tend to injure the burning quality of tobacco. When lime is used in the tobacco rotation it seems wisest, therefore, to use it immediately after the tobacco comes off and before the wheat or oats are

seeded. It would thus tend to help the immediately succeeding crops, particularly the grass, and would be largely out of the way, so far as its direct effect is concerned, by the time the field is again planted to tobacco. On tobacco lots, lime should not be used ordinarily oftener than once in about four years and at a rate not to exceed one-half ton of quicklime or its equivalent per acre.

VARIETIES OF FLUE-CURED TOBACCO.

A great array of so-called tobacco varieties might be listed, but many of them would represent but little, if any, real variation in type. There is, however, one broad differentiation among the many so-called varieties, based on shape and size of leaf, which can be readily observed. Thus we have the broadleaf types, represented by such standard sorts as Warne, Yellow Oronoco, White-Stem Oronoco, Big Oronoco, Adcock, Adkin, Willow-Leaf, Gooch, Tilley, and Hester, and the narrow-leaf sorts, as Narrow-Leaf (little) Oronoco and Flanagan.

Throughout the New Belt and on the lighter soils of the Old Belt section the broadleaf types are generally preferred, as they are better adapted to the production of smokers, cutters, and wrappers. On the stronger soils of the western part of the Old Belt section, particularly westward from Rockingham County, N. C., and Henry County, Va., the narrow-leaf sorts are general favorites. These narrow-leaf varieties will make good, rich filler on suitable land, and by somewhat closer planting on improved land a large yield per acre can be grown without the individual leaves becoming overgrown and coarse. Flanagan and some of its subtypes, particularly the Improved Flanagan, are rather large-leaf types, about midway between the narrow-leaf and the broadleaf sorts, and are well adapted to quite rich land. The variety known as Short-Stalk Flanagan closely resembles the Narrow-Leaf Oronoco. The Flanagan types are perhaps the most vigorous growers and heaviest yielders of any of the flue-cured varieties, but they are a trifle later in maturing than the others.

On the fine, bright soils the broader leaf types are generally most popular. The Warne, a standard wrapper type, is perhaps the most popular of any. The White-Stem Oronoco, Willow-Leaf, and Gooch are favorites in certain parts of the New Belt section. The Adcock is a great favorite in the noted wrapper-producing section in the southern part of Granville County, N. C. The Adkin is also a popular broadleaf sort in certain sections of the Old Belt and has the merit of being some days earlier in maturing than most of the other standard sorts, but this earliness is probably somewhat at the sacrifice of yield.

The distance between the leaves on the stalks is somewhat greater on these broadleaf types than on the narrow-leaf sorts, the spacing being particularly wide in the case of the Adcock. It should be noted, perhaps, that any of these varieties will have the leaves more closely or wider spaced according to the nature of the soil, especially in respect to moisture conditions. With an abundance of moisture the spaces between the leaves will be wider, and under droughty conditions the leaves will be crowded much more closely together. This is a general principle in respect to all vegetation.

FIG. 2.—A seed head of tobacco covered with a paper bag to prevent mixing.

SELECTION AND CARE OF SEED PLANTS.

In selecting seed plants, close attention should be given to all the points that go to make up the ideal plant, according to the standard which the grower should have clearly in mind. The largest plants in the richest part of the field are not necessarily the best for seed purposes.

Pure strains of seed can be saved with certainty only by covering the seed head during the blossoming period so as to prevent mixing or crossing with inferior plants or suckers by the passing of insects from flower to flower on different plants. For this purpose an ordinary light-weight but strong paper bag of about the 12-pound size, such as can be obtained at any grocery store, is most practical. A day or two before the first flowers open the bag should be tied about the head (fig. 2), which first has been trimmed to a "crow-foot." The bag should be loosened and raised up every few days, as the seed head grows, and the

flower débris shaken out. After all the flowers of the crow-foot are opened and the seed pods begin to swell, the bag may be removed if desired, but it will be necessary to keep all other flower branches and buds constantly picked off.

In harvesting, only the fully matured and ripe pods should be saved. Such as are underripe should be picked off and discarded. After they have been shelled out, the lighter, imperfect seeds should be got rid of by some simple winnowing device, for the same reason that wheat or other seed are cleaned of inferior grains before sowing. A satisfactory separation of the seeds can be made also by settling them in a glass of water. After half or two-thirds of the seeds have sunk to the bottom, at the expiration, probably, of two or three hours, the floating seeds may be skimmed off and the heavy seeds that have settled can be dried on blotting paper.

PREPARATION AND CARE OF THE SEED BED.

It is the almost universal custom throughout the entire flue-cured district to prepare the seed bed on freshly cleared land, either in the woods or in some other suitable location. The reason for this is that there is an abundance of humus in such land. It is not compacted and baked by heavy rains and the sun, and the plants grow faster on fresh land than on old land.

The particular spot of land chosen should be loamy and mellow and naturally moist, but having good drainage and free from standing water at all times. It is desirable usually to locate the bed near a stream of water. At such places the land is apt to be naturally moist, and in the event of an extreme drought the bed can be more readily watered artificially.

An exposure to the south or east will give the earliest plants, although it is best to have at least two beds, one a little later than the other. The spot chosen should also be as free from weeds or grass as possible, and generally, as further insurance against a weedy bed and to kill soil insects as well, the bed should be burned during the winter before it is seeded. If plenty of good dry brush is available (pine brush is best) the bed can be most easily and cheaply burned with this material. Usually it is necessary to haul the brush at least a short distance. This can best be done by piling it compactly on a 12-foot wagon frame. About eight good loads of well-compacted brush will usually be required for a bed of 100 square yards. Before the brush is piled on the bed, the leaves or other litter should be raked from it, as they hold moisture and would tend to prevent the heat from penetrating the soil to a sufficient depth. If brush in sufficient quantity is not available or it is desired to burn the land very thoroughly, a combination of wood and brush may be used. Burning in this way will require about 3 cords of wood for 100 square

yards. Long poles or skids are laid along the ground at intervals of about 4 feet. Across the ends of these skids on the upper side of the bed, brush and wood is piled about 4 feet wide and 3 feet high. This pile is set on fire in several places. With considerable attention it will generally burn down sufficiently in about a half hour. The embers are then pulled down with hoes or hooks with long handles to the adjacent strip 4 or 5 feet wide just below. The fires are renewed by piling on more wood and brush and allowed to burn down for another half hour, or until the soil beneath seems well heated and dried out to a depth of about 3 inches. This process is repeated until the whole bed is gone over.

A spell of dry weather when the ground is free from frost should be chosen for burning. If the soil is wet, it will take much more heat to burn with the same efficiency because of the increased amount of water to be evaporated, and in some cases the physical condition of the soil might be injured by burning when the soil is too wet. The bed may be burned at any suitable time during January or February, or even as late as the middle of March in the western part of the Old Belt section. The burning of the soil puts it into good tilth, and generally it can be worked up and sowed to best advantage at that time. A disadvantage is the danger of washing the seeds away by heavy rains or that they may sprout prematurely during protracted warm spells in the winter months and be killed by later cold snaps. This latter incident, however, is a rare exception, and generally the seed will not come up till about the last of February or first of March in the New Belt section or about the middle of March in the western part of the Old Belt. In fitting the bed after burning, or if fitted without burning, as is sometimes done on weed-free land, a single-shovel colter plow is of great service. After raking off the embers the bed should be gone over both ways with the single-shovel plow and then gone over several times with a drag harrow. This will minimize the amount of handwork required in fitting to a fine surface tilth. Fertilize liberally by raking in about 1 pound per square yard of some good fertilizer such as 3–8–3 or its equivalent. If the bed has been burned, the ashes will give enough potash, but phosphoric acid and ammonia will be required. Blood or cottonseed meal are good forms in which to apply ammonia at the time of seeding, but about the time the plants should come up a top-dressing of nitrate of soda, at the rate of about 5 pounds per 100 square yards, will start the plants to growing vigorously. Unless absolutely necessary, nitrate of soda should not be applied to a plant bed after the plants have attained much size, because it will force them into a late tender growth at transplanting time and they will not be sure to live.

A moderately heaping tablespoonful of good seed is enough to sow 100 square yards of bed. If too much is used the plants will be

spindling from being too thick, and they will not thrive when transplanted. This quantity of seed should be mixed with about 1 peck of some good bulky material, such as fine, dry fertilizer. In sowing, the bed should be gone over both ways in order to insure an even distribution. One of the best methods of covering the seed is by tramping with the feet. This compacts the soil and presses the seed slightly into it. If the bed is sufficiently smooth, a hand roller might be used, but it would not usually be practicable for use on an ordinary bed in the woods.

After danger of snow is over, not later than about 10 days before it is time for the seed to come up, the bed should be boxed in tightly with poles or plank about 6 inches high and covered with plant-bed cloth. The cloth will retain the warmth and make the plants earlier and, if tight all around and free from holes, will keep out flies and other insect enemies. The cloth is kept from sagging to the ground by stretching wire on poles across the bed at intervals of about 5 steps, or by placing wickets made from green switches here and there over the bed.

About the time the plants begin to come up it is a good plan to sow an additional half tablespoonful of seed over the bed on top of the cloth. The rains will carry the seed through the cloth into the soil and this extra seeding will make a good late drawing of plants which may prove useful, and in any case will not interfere with the first sowing.

If the bed gets weedy it must be picked over by hand, preferably during a spell of wet weather. A few days before transplanting, the cloth should be removed to harden the plants, or this may be done earlier if the plants are becoming overgrown.

Always to have an abundance of plants when needed is a fundamental factor for success in tobacco growing. Without plants the whole year's work is a failure. A good bed may supply as many as 40,000 or 50,000 plants from 100 square yards in two or three drawings, but it is not safe to count on more than 10,000 to 15,000 plants from each 100 square yards sowed. A plant bed with the cloth removed and plants ready for transplanting is shown in figure 3.

EARLY AND LATE PLANTING COMPARED.

The transplanting season in the New Belt section begins early in April in South Carolina and continues until as late as the middle of June in the western part of the Old Belt, although even in this latter section the main plantings are made from about the middle to the last of May. In the New Belt the bulk of the crop is generally set by May 1. The tobacco which reaches maturity and is harvested while the weather is yet warm, say, from the middle of August to the middle of September in the western part of the Old

Belt section, generally will be decidedly better in quality, particularly in respect to color, than the later cuttings. In the New Belt and the eastern part of the Old Belt the harvest season, running through July and August, naturally comes in warm weather, and this is a distinct advantage, but even there the earlier curings are likely to be best in quality. Fairly early planting is to be preferred, therefore, even in that section, and the plants live better if transplanted before the weather becomes too hot and dry. But in the western part of the Old Belt the grower should make a strenuous effort to have an early crop by planting early and by choosing land on which the plants will grow quickly.

FIG. 3.—A bed of tobacco plants, with the cloth cover removed, ready for transplanting.

PREPARATION OF THE SOIL FOR TRANSPLANTING.

As already indicated, the best system of tobacco farming, particularly in the Old Belt, will provide for the fall or winter plowing of the tobacco land. The winter freezing will mellow the soil and the winter and spring rains will be better held for the use of the growing crop during the summer. Little faith should be placed in the oft-heard assertion that shallow plowing (3 or 4 inches) is best for tobacco, although in the Old Belt it probably would be unwise to turn up any considerable quantity of a stiff clay, but unless a field can be plowed as much as 6 inches deep without so doing, it is probably not well suited to bright tobacco.

If the field has been fall or winter plowed no further preparation will be necessary in the spring until it is time to fit the land for transplanting. The disk harrow is the best implement for working the soil into a good tilth, if followed by a drag harrow just before laying off the rows.

DISTANCE OF PLANTING.

The space allowed each plant in the field, that is, the distance of planting, is a matter of considerable importance in determining the quality and to some extent the yield of tobacco produced. Careful attention should be given the matter of proper spacing when setting out the crop, and a strenuous effort should be made to secure a good, even stand over the whole field as promptly as possible. The real importance of this matter will be clear by observing the effects of a broken stand of plants on an improved field just before the harvest. Where the stand is regular the tobacco will probably be smooth and fine and ripened nicely. But where some of the plants are missing the surrounding plants will be overgrown and coarse and will neither ripen, yellow, nor cure well. Because of the increased feeding space, without competition from other plants, they are overfed and rendered overgrown and coarse and of greatly diminished value.

In the flue-cured district the customary distances of planting give about 4,000 to 5,000 plants to the acre. In the New Belt it is more usual to space the rows about 4 feet apart, with the plants from 2 to 2½ feet apart in the rows; and in the Old Belt, particularly in the western part, the more common distance between the rows is 3½ feet, with the plants from 2½ to 3 feet apart in the rows. The reason for the wider spacing of the rows in the New Belt doubtless is largely because of the greater convenience in getting through the wider rows with the mule and truck used at harvest time for hauling out the leaves, and also because the tobacco grows taller and would thus tend to more self-shading in the narrower row. In some sections of the New Belt it is customary to make every eighth row 6 inches wider than the others, and at harvest time the mule draws the truck or slide, into which the leaves are put, through this wider space with less danger of breaking the tobacco standing in the rows on either side.

As the soil becomes richer by better farming methods, much of the tendency for the tobacco to grow coarse and dark can be overcome by thicker planting combined with somewhat higher topping. In some cases 3½ feet between the rows and 2 feet between the plants in the row would not be too close for the best results in yield and quality.

LAYING OFF THE ROWS AND TRANSPLANTING.

For laying off the rows the bull-tongue single-shovel plow is a good implement. After distributing such fertilizer as is to be used in the row, it should be incorporated with the soil by going along the row with a double or single shovel plow or other suitable implement, after which the rows are bedded by turning two furrows together with a 1-horse plow. In a few sections a 4-furrow bed is

made, on the theory that the wide bed holds the moisture better and gives the plant a better start. In most sections, however, the consensus of opinion seems to be that the 2-furrow bed is just as satisfactory. In the light soils of the New Belt the bed is put into final shape for planting by dragging down and slightly packing the top of the ridge. A cotton planter drawn along the row is frequently used for this purpose, the plow in front serving to knock off and flatten the ridge while the roller behind compacts it. A plank or log drawn by a mule and wide enough to cover two or more rows at a time is also a satisfactory device. Figure 4 shows an ingenious implement for this purpose devised and used by Mr. B. F. William-

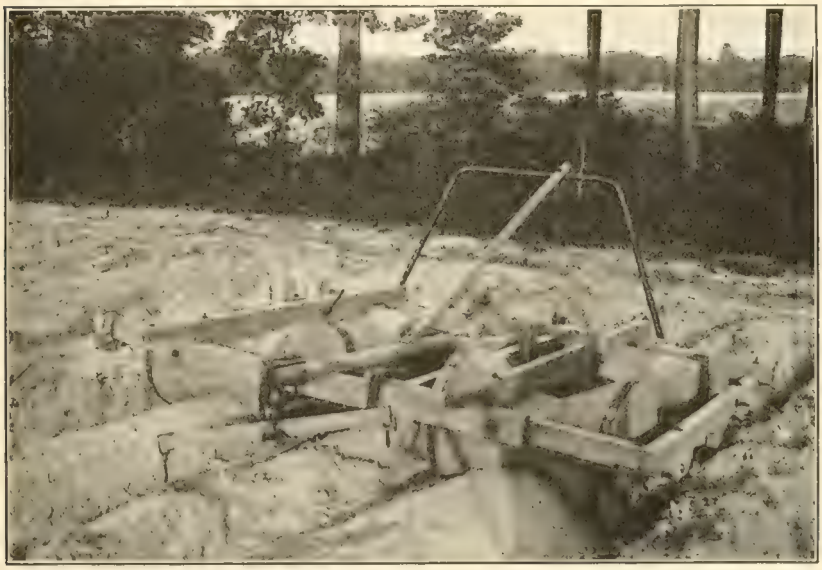

FIG. 4.—An ingenious form of ridge leveler, for compacting and leveling the beds or lists upon which tobacco plants are to be transplanted.

son, a noted grower in Darlington County, S. C. This device, by means of the spool-shaped rollers on the front, rounds off the bed so that water can not form pools and drown the plants, and it flattens and compacts the bed at the same time.

On the rougher soils of the Old Belt section it is more customary to go over the field with a hoe, cutting through the bed and making a pat at each spot where a plant is to be set. The objects of the bed are to get a body of good, soft soil in which to set the plant and to provide that surface water during heavy rains may flow away from the plant and not stand around it and either cover it with silt or drown it outright. But in attaining these objects the less the elevation of the plant the better.

When transplanting, so far as possible use only good, strong plants of uniform size. The plants should be kept straight and the roots well mulched and protected from the drying wind and sun in order to retain their vitality as much as possible, which will help materially in insuring a good start in growing. In the flue-cured districts the greater portion of the crop is transplanted by hand in a natural season, using a peg for making holes and pressing the earth to the roots. But more or less setting with water in times of drought is resorted to almost every year in some sections. For this purpose a special hand planter is often used. This is an effective and inexpensive implement. It has the merit of putting the water imme-

FIG. 5.—A 2-horse machine transplanter at work. A machine of this kind may be seen here and there in the flue-cured tobacco district, particularly in the New Belt section.

diately around the roots where needed, and it is thought that the plants grow better than when set and hand watered with dippers. The 2-horse machine setter is in use to a limited extent in some neighborhoods, but, of course, is adapted only to smooth fields and soft land. A view of one of these machine setters at work in Snow County, N. C., is shown in figure 5. The expense of machine setting is about the same as for hand setting, but there is the advantage of being able to go ahead with the setting when the plants are right, independently of the weather. The water is put at the roots and the plants live as well or better than hand-set plants.

In from three to five days after the field is set out it should be gone over again and carefully replanted with the best plants avail-

able. A strong effort should be made to secure a perfect stand as soon as possible. This is a very important point in securing the best results from tobacco.

CULTIVATION OF THE GROWING CROP.

In order to encourage a quick start in growing, a good horse cultivation and careful hand hoeing should be given the newly set tobacco as soon as it has become established, generally after a week or ten days. A little fresh earth should be drawn about each plant, but care should be taken not to loosen the newly established roots. A second hand hoeing may be needed about two weeks later; but in any case the young tobacco should be horse cultivated every week or ten days, according to conditions, until about topping time. After topping, cultivation should be discontinued, as the tobacco will ripen better if the cultivation is not continued too late. From four to six horse cultivations can generally be given to advantage, although many growers usually give but three. If the soil is at all hard, the first one or two cultivations should be deep, to thoroughly loosen up the soil and render it mellow. A double-shovel plow with narrow teeth is useful for this purpose. Later on, as the roots begin to spread through the row, only shallow cultivation should be practiced. For these later cultivations especially, the ordinary 5-toothed cultivator, fitted with an 18-inch or 20-inch sweep on the rear tooth, is a very satisfactory implement. The sweep attachment fills the furrows made by the teeth and works the soil toward the plant. Such a slight raising of the soil along the row is undoubtedly desirable; but it is open to question whether the excessive bedding of the row with the turning plow, as commonly practiced in "laying by" the crop, as it is called, at the last cultivation is desirable, except perhaps in very wet years or on soil characterized as wet or "spouty."

DISEASES AND INSECT ENEMIES.

Specking, or "diseasing," as it is generally called, is the most common disease injury to which tobacco in the flue-cured district is subject. It is believed to be a fungous disease, disseminated by spores, perhaps of several species. The trouble is favored by a moist atmosphere and by sappy tobacco. The only practical method of reducing the injury from this trouble, so far as known to the writer, is by using potash more liberally in the fertilizer, which seems to increase the resistance of the plant to the disease.

Root-knot, caused by nematodes or eelworms of semimicroscopic size, also does great damage, particularly on some of the lighter soils of the New Belt section in South Carolina and North Carolina. Nematodes also attack a long list of plants other than tobacco, and

the only way to free a field from the pest is by absolutely clean fallow cultivation for a year or two or by growing only immune crops for two or three years so as to starve them out.[1]

The Granville wilt, first observed in the eighties of the past century, is a bacterial disease communicated through the soil. In the flue-cured district the infested area so far as known is largely confined to one soil type in the southern part of Granville County, N. C. This soil naturally produces a very fine type of wrapper tobacco. The disease is spreading quite rapidly locally and now occupies a considerable area in that section, embracing one of the very best bright-tobacco areas which we have. Once the soil is infected, no practical means have yet been devised for controlling the disease, and it is difficult to prevent it from gradually spreading to other adjoining areas. While the disease is confined to a comparatively restricted area, it is, nevertheless, a very ruinous one in that section.

The mosaic disease, frequently spoken of as calico or "mottling," probably is the most widespread of all the tobacco diseases. Until recently it has been quite generally supposed to be simply a manifestation of malnutrition, caused by unfavorable growing conditions. It has long been known to be infectious, however. It can be spread, for example, by rubbing the leaves of a diseased plant and then likewise rubbing the leaves of healthy plants. Recent tests by Mr. H. A. Allard, of the Office of Tobacco and Plant-Nutrition Investigations, Bureau of Plant Industry, go to show that the disease is a specific infection and in the absence of such infection can not arise from impaired nutrition. It has been discovered that certain aphids or plant lice are largely responsible for the dissemination of the disease. Other names, such as frenching, walloon, etc., are applied to a group of diseases resembling true mosaic more or less. Such diseases as the so-called "sore-shin" and "rotten-stalk" are sporadic and occasional in their appearance, and are thought to be due primarily to some mechanical injury which may admit disease germs that attack the tissues locally.

The occurrence of so-called "dead spots" here and there over a field, particularly in the Old Belt section, in which the plants, without apparent cause, fail to make any growth, is a phenomenon frequently observed, especially in a dry summer following a very wet spring. The soil of these spots generally appears to be in as productive a condition in all respects as other parts of the field. The roots of the plants show no apparent injuries of any kind or evidences of disease. No fully satisfactory explanation of the cause or means of remedying the trouble are known to the writer.

[1] For a full discussion of nematodes and methods of eradication, see "Root-Knot and Its Control," U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 217, 1911.

Tobacco at various stages of its growth is subject to the attacks of a number of insect enemies, for a list of which, with recommendations for controlling them, the reader is referred to Farmers' Bulletin 120 and to circulars 123 and 173 of the Bureau of Entomology.

TOPPING AND SUCKERING.

In about eight or nine weeks after transplanting, in seasons of normal growth, the tobacco plants will begin to show signs of sending up a seed head, "buttoning out," as it is called. The topping season is now at hand. In topping, the aim is to improve the quality of the leaves produced and to aid the different plants in maturing at the same time. Experience and judgment are necessary in this important operation. From 8 to 12 or more leaves, excluding undeveloped leaves at the bottom, are commonly left to mature on each plant. Primarily the number of leaves that should be left depends upon the richness of the soil and the vigor of the plant. If the plant is topped too low the yield will be unnecessarily sacrificed and the remaining leaves will be coarse and overgrown. Sometimes in the Old Belt section some of the inferior bottom leaves are primed (broken) off and discarded at the time of topping the plant. In the New Belt, where harvesting by picking the leaves is general, it is customary to top somewhat higher than in the Old Belt, often to as many as 16 or 18 leaves.

The time required for a plant to mature depends somewhat on the number of leaves left on it. In order to bring as many plants as possible to a uniform state of ripeness at one time it is customary to let the bud come out somewhat higher and to top to more leaves at first and then to one or two less each subsequent time the field is gone over.

Soon after the plants are topped, suckers will begin to grow from the axils of the leaves. The first suckers will appear at the top of the plant, and so on downward as the upper ones are broken off. Two full sets of suckers will usually grow on a plant, but it will be necessary to go over the field as many as five or six times at intervals of about one week in order to get them all. The whole object of topping will be defeated if these suckers are allowed to grow, and generally they should not be permitted to get more than about 4 inches long before they are removed. Sometimes, however, when a period of wet weather comes just as the tobacco should be getting ripe, it may be of advantage to let the suckers alone temporarily, as their growth will tend to absorb the energies of the plant and prevent the leaves from taking on a second growth, which would make them coarse and dark.

HARVESTING.

When the tobacco is to be harvested by cutting the entire plant, as is customary in the Old Belt, the general condition of the whole plant must be considered, allowing the top leaves to get as ripe as possible without too much offsetting the loss at the bottom of the plant. Generally, a plant will be ripe in from 90 to 100 days after transplanting, and in about 35 or 40 days after topping, but this is subject to great variation, dependent primarily upon seasonal conditions. When the tobacco is to be harvested by priming, or picking the leaves off as they ripen, the harvest begins whenever the bottom leaves demand it, generally in about two or three weeks after topping, or even before topping in some instances. The field subsequently will need to be gone over about once a week until all the

FIG. 6.—A fine field of tobacco nearly ready for harvest in the Old Belt section.

leaves are removed, usually about four or five times in all. Figure 6 shows a fine field of tobacco in the Old Belt section near Winston-Salem, N. C., which is about ready for the harvest, and figure 7 gives a view of a field in the New Belt section near Greenville, N. C., which is in actual process of harvest by the priming method. The more common form of law-wheel truck for hauling out the leaves is shown in figure 8. To cure up sweet and with good color, particularly on the stiffer class of soils of the Old Belt section, the tobacco must be ripe when harvested, but if it is overripe it will be lacking in toughness and luster.

The question of the comparative merits of the priming method as compared with cutting the entire plant is somewhat complicated by local conditions and is a matter of considerable controversy. Theoretically the priming method, whereby each leaf is taken at approxi-

mately its stage of maximum development, should be best. The priming method requires somewhat more labor than the cutting method, and the New Belt section has this labor in better supply,

FIG. 7.—Harvesting tobacco by the priming method. The form of truck shown, with a high body which passes over the tops of the standing plants without damage, is convenient for hauling out the leaves.

owing to the surplus that can be shifted temporarily from the cotton fields. The lighter soils of the New Belt and the consequent greater tendency in many cases for the bottom leaves to waste before the top

FIG. 8.—A common type of low-wheel truck in the New Belt section, in which the tobacco leaves are placed as they are picked.

leaves are ripe perhaps makes the priming method relatively more necessary there than in the Old Belt, where the stiffer soils retard deterioration of the bottom leaves while the top leaves are ripening.

In seasons of normal growth, under the conditions existing in the Old Belt, when all the leaves of the plant mature at approximately the same time, quite likely the crop may be most economically and satisfactorily harvested by cutting the entire plant at one time. But when, as in 1912, a prolonged drought causes the bottom leaves to turn yellow and waste away while the top leaves are still quite green, there can be no question that it is much better to prime off the leaves as they ripen, as was actually done by many growers. If priming had been universally followed in that year, undoubtedly it would have saved many thousands of dollars to the tobacco growers of the Old Belt section. Figures 9 and 10 show characteristic harvesting scenes in the New Belt and Old Belt sections.

FIG. 9.—Tobacco harvest in the New Belt section. Stringing the primed leaves under the shade of a tree.

CURING AND HANDLING.

The expert curer exhibits his skill from the very first, as he begins to harvest the crop. He cuts or primes, having clearly in mind what he expects to accomplish in making the cure. For a uniform curing of good color, a first requisite is that the barn be filled with plants or leaves of uniform ripeness and character.

The first step in curing is to yellow the leaf properly. This takes place while the plant is yet living but is slowly approaching death from starvation, since the food and moisture supply is cut off. To expose too long to the sun and air after cutting, even though actual sunburning does not result, greatly diminishes the vitality of the cells of the leaf and it will not yellow so well. The tobacco should, therefore, be housed without excessive wilting or long exposure to the sun and wind.

As soon as the leaf is dead or dry, further yellowing takes place only very slowly, and if there yet remains any considerable amount of moisture in the leaf a red or brown color will immediately begin to develop. In curing, one should keep well in mind the principle that it is necessary to preserve the life (cell activity) and at least some of the moisture while the leaf is yellowing, and so manage as to have the moisture exhausted by the time it is completely yellow, or, rather, a little before it is fully yellow, as the most satisfactory cures and clearest colors generally follow when the leaf is dried out with some green remaining in it. Tobacco yellows best, especially in the first stages, when the temperature of the barn ranges from about 80° to

FIG. 10.—Harvesting tobacco by the whole-plant method, showing a good type of hauling frame, which should be more generally used.

100° F., but it will continue to yellow in the later stages up to 115° or 120°. As the yellowing proceeds, it is well, toward the later stages, to increase the heat slowly toward these higher temperatures and to begin to dry a little on the yellowest leaves by admitting a little extra ventilation.

In order to obtain the best results in yellowing under varied conditions, it is best to have the barn very tight, so that in the earlier stages of yellowing the desired temperatures may be obtained without exhausting the moisture too rapidly. As the yellowing progresses, however, it is necessary that this moisture be gradually and later rapidly removed; and to accomplish this to the best advantage

it is highly desirable that the barn be so arranged as to be fully and freely ventilated, so that it may be possible to steadily remove the warm, moisture-laden air as it becomes saturated.

In drying out an ordinary 16-foot or 18-foot barn, holding say 500 sticks of cut tobacco, about 5,000 pounds of moisture (water) must be removed. The movement of the air through ventilation is the only means of getting rid of this large amount of moisture. Raising the temperature of the air increases its capacity to absorb moisture and creates a draft, provided means are afforded in the construction of the barn for letting out the air rapidly at the top and for letting it in at the bottom. For the outlet at the top a short lever device at each end of the peak for raising the ridgeboard by means of wires

FIG. 11.—A good type of flue-curing tobacco barn, showing the ridgepole ventilator raised. The mouth of one of the bottom air inlets is seen just under the open door.

reaching to the ground, as shown in figure 11, is a handy and simple arrangement. The slit left open when the ridgeboard is raised should be about 5 inches wide. To admit air at the bottom there is always the door, which can be partially opened at will; but this method gives an excess of air immediately in front of and over the door. For an even distribution of the air in all parts of the barn, sewer pipes, about the 4-inch size, set in the wall at appropriate places, will make a good arrangement for the bottom ventilation. The pipes should be set in the wall close to the ground, but just above it on the outside; they should dip just below the ground on the inside, the openings of the different pipes being, respectively, under and near the end and at the middle of each length of flue, including the returns. Each air pipe should be fitted on the outside with a suitable wooden

stopper, to be closed or opened more or less as the conditions of curing require.

Generally it will be found best to begin to open these ventilators and raise the heat somewhat before the tobacco is fully yellow, so that the moisture will be sufficiently exhausted by that time to prevent reddening or sponging. The draft should not be too strong, especially at first, but it should be sufficient to effectively remove the air before, or at least by the time, it becomes saturated.

In light-bodied tobacco, as grown on the lighter soil types, the yellowing process will generally take about 36 to 48 hours under average conditions; but if the tobacco is very heavy and dark, as frequently occurs on the filler soil types in the western part of the Old Belt section, it may be necessary to consume three or four days in the yellowing process. This will be especially necessary if the soil on which the tobacco was grown was rich in ammoniates or if the tobacco was a little underripe when harvested. Under these circumstances there will be an abnormal quantity of reserve nitrogenous food material in the leaf, and it will be necessary to avoid applying much heat for several days or drying the leaf much, in order that these food materials may be consumed by the life processes of the plants, else the tobacco will be rank smelling, dark, and objectionable rather than sweet and agreeable. This explains why it is such a common practice with those who grow tobacco on the more clayey soils of the western part of the Old Belt to let the tobacco hang in the barn for a day or two before any fire is used at all and then to keep the temperature comparatively low so as to prolong the yellowing period, which in this case is really a ripening or sweetening period as well.

When the yellowing of the leaf is approximately completed, during the later stages of which the temperature has been maintained perhaps at from 110° to 120° F., it is then the custom to move up the temperature quite rapidly, say at the approximate rate of $2\frac{1}{2}$ degrees per hour, to 130° or 135°, and to hold it at that point until the leaf itself is entirely dry throughout the barn, or at least on the bottom poles. It is a general rule of curing that it is not safe to exceed this temperature for any length of time before the leaf is dry, because at about this temperature, or a little above, the cells of the leaves are rapidly killed, and when killed they at once release the moisture they contain, which comes immediately to the surface and results at once, by oxidation, in a blackish discoloration known as scalding. Scalding may occur at a much lower temperature than this when the tobacco is full of sap, in the early stages of the cure. When the leaf is dry throughout the barn the ventilators may be partially or perhaps wholly closed, to save fuel, and the heat gradually moved up at the rate of about 5 degrees per hour to about 175° for the light,

bright types, at which point the heat is maintained until all the stems and stalks are completely killed and dried out and the cure finished. Tobacco will tend to redden slightly at a temperature of 180° or above. In the filler districts in the western part of the Old Belt section the stems and stalks are more commonly killed out at about 200°; and sometimes for the last few hours as much as 225°, or even more, is maintained. These higher temperatures are thought to sweeten the leaf and a reddish, rich-looking "face" is imparted, known as "scorching." These excessively high temperatures, however, while still extensively used, may make the leaf more or less brittle, which renders it objectionable for chewing purposes.

After the cure is finished, the tobacco ordinarly should not be allowed to come in high order for any length of time, especially in warm weather, or reddening and perhaps worse damage from mold or decay may result. On the other hand, to keep the tobacco for some time in moderate warmth and moisture may be an advantage in eliminating any remaining green color.[1]

In the South Carolina portion of the New Belt a large proportion of the tobacco is generally sold as soon as it is cured, without either assorting or tying the leaves into hands. Of course, the system of priming the leaves as they ripen makes for an approximate grading, since the leaves taken off at any one time would be from approximately the same portion of the different plants, representing the bottom, middle, or top leaves, as the case might be. When sold in that way the tobacco is allowed to come in soft order as soon as possible (generally in a day or two) after the cure is finished. The leaves are removed from the strings and packed into the wagon body as straight as possible, and the load is immediately taken to the warehouse and sold. In other sections, however, the tobacco is more generally first bulked in the packing house on the sticks as it comes from the curing barn, either in the shingle bulk, as is more customary in the New Belt section, or in the square coop, as is more common in the Old Belt section; or it may be hung up in the packing house or curing barn, the sticks being crowded closely together to keep the leaf from coming into too high order, which would cause it to turn red. The tobacco is then graded and tied into hands at any time convenient to the grower and sold as desired.

Except in cool, very dry weather, tobacco will generally come into order so that it can be removed from the curing barn on about the second morning after the cure is finished. All the doors and ventilators should be opened at night to let in the moist air. The web of the leaf will generally become fairly soft the first night. The next day the barn should be tightly closed if the weather is dry, in order to retain the moisture. At night the barn again should be opened

[1] For more detailed information in regard to the process of curing tobacco, see Farmers' Bulletin 523, entitled "Tobacco Curing."

fully. The stems generally will become soft enough during the second night so that the tobacco can be removed and bulked or rehung in the storage or packing house without breaking.

In softening tobacco for stripping and assorting, an ordering cellar is a great convenience. The cellar generally is dug under the packing-house floor to a depth of 6 or 7 feet, and should be large enough to hold at least a curing of tobacco. The cellar is fitted with light framework on which to hang the sticks of tobacco. Care must be taken to locate the cellar where there is sufficient clay in the subsoil so the walls will stand firm, and it must be situated so that

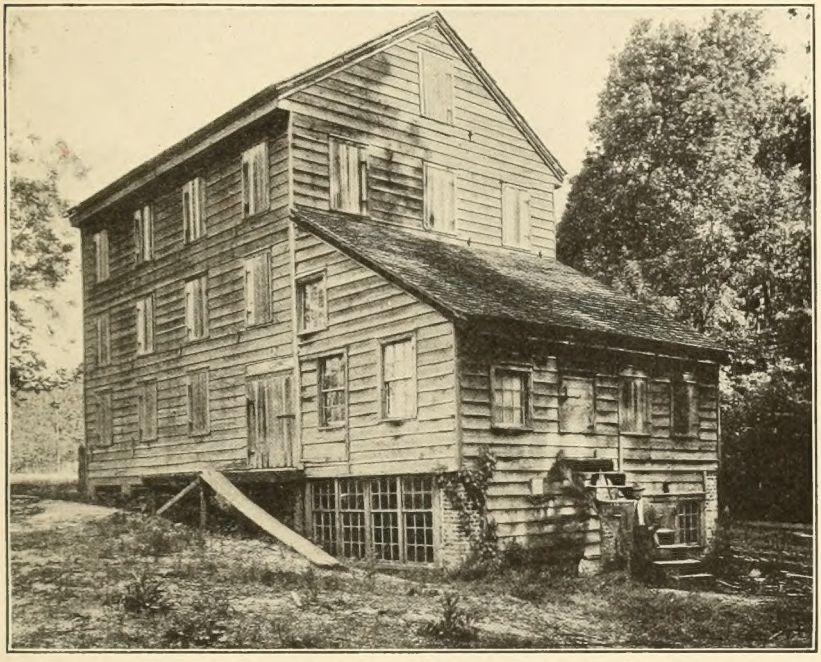

FIG. 12.—A good type of tobacco storage and stripping house, with an ordering cellar under the building.

water will not rise or flow into it. It should be banked around the outside to keep out surface water, and it would be safest to put a drainpipe in the bottom to carry off seepage water. At least one small glass window also should be provided.

The stripping room is usually built as a shed on one side of the packing house, into which the ordering cellar opens by a door and steps. The best light, free from glare for stripping, will be obtained if the windows are mostly on the north side of the stripping room. A well-appointed storage house, ordering cellar, and stripping room is shown in figure 12. The cellar is under the main building, and the stripping room is in the shed to the right.

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One thing which the tobacco grower must constantly have in mind while the tobacco is in bulk or storage is the danger of damage by mold, especially during protracted periods of warm, moist weather.

In assorting tobacco as it is stripped from the stalk, which is the common practice in the Old Belt, about four fundamental grades generally will be obtained from a given plant. There will be the trashy lugs, clean lugs, leaf, and tips as they are taken from the bottom and then on to the top of the plant. In the actual assorting of an entire curing a number of other secondary grades will be made, sometimes as many as 8 or 10 in all, based upon differences in color, texture, and body. A great number of grades are recognized by the trade as wrappers, cutters, export leaf, fillers, smokers, etc., and each of these is subdivided into a number of subgrades, but, of course, only a few of them would appear in any single crop or curing. The better grades of lugs and the leaf are tied into comparatively small hands of about 10 or 15 leaves each, but the poorer lug grades are generally tied into larger hands of 20 to 40 leaves each. The hands or bundles are tied with a leaf, which is folded for this purpose by turning both edges backward and inward so as to form a neat band. This is then deftly given a couple of turns tightly around and partially or completely covering the butts of the leaves forming the bundle, beginning with the tip of the tie leaf. The butt end of the tie is tucked through the hand between the leaves so as to wedge and hold the tie leaf in place.

Before placing tobacco on the market, it should be brought into good but not too high order, and its appearance will be improved if it is bulked down either on or off the sticks for a day or two. In most sections of the flue-cured district the farmer can dispose of his tobacco either by direct sale on the warehouse floor or through the grower's pooling organization. If sold on the warehouse floor, care should be taken to avoid a glutted market, for at such time the prices are generally somewhat reduced because the buyers can not handle and take care of it as fast as it comes in.

The entire cost of producing and marketing flue-cured tobacco is estimated at 6 to 10 cents a pound, according to conditions.

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